Space Weather Technical Forecast

Issued on Wednesday, 09 February 2022 at 12:27 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Likelihood of G1/Minor Storm activity on day 1 (09 February) and a chance on day 2 (10 February), associated with CME arrival. Active electron fluence expected days 1 and 2 (09 and 10 February). Chance of an M-class flare.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been low over the last 24 hours, with occasional C-class flares. The most energetic of these was a C5.1 at 08/2144 UTC from 2939 (Cho/Beta), a large mature region in the southwest quadrant. Two regions in the northern hemisphere, 2941 (Fai/Beta) and 2940 (Dai/Beta) are both large, carry a flare risk. 2943 in the southeast, is small and benign and uni-polar (Hsx/Alpha). No further Earth directed CMEs have been observed in available imagery.

Solar Wind / Geomagnetic Activity: The solar wind at L1 has declined a little further over the past 24 hours from 440km/s to 400km/s. Density was below average throughout. Interplanetary magnetic field strength has been weak, with the north-south component, Bz, also varying weakly. Phi angle was predominantly negative (towards the Sun). Geomagnetic activity was Quiet (Kp 0-2)

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) measured at GOES 16 was at background levels. The high energy electron flux (greater than 2MeV) has been above the high threshold throughout, peaking at 1.14e4pfu at 08/1535UTC. Electron fluence values are above the Active (1e8 integrated pfu) threshold on a rising trend, reaching 5.59e8 integrated pfu at 09/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is forecast to remain low through the next four days, with a chance of an isolated M-class flare due to the three large active regions currently observed on the visible side of the solar disc.

Solar Wind / Geomagnetic Activity: A CME which left the Sun on 06 February is forecast to arrive at the Earth on 09 February with an estimated speed of 800km/s. The CME may then perturb the geomagnetic environment around the Earth over the following two days. The high speed stream from coronal hole 53 is expected to connect with the Earth late on day 4 (12 February). Geomagnetic activity starting Quiet before becoming Unsettled to Active on arrival of the CME with a Chance of G1/Minor Storms. Residual and decreasing effects of the CME through days 2 and 3 (10 and 11 February). The onset of the high speed stream from coronal hole 53 may then produce further G1/Minor Storms.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is forecast to be at background levels, but with a slight chance of rising close to, or just above, the S1 level given any significant flares. High energy electron flux is likely to fall below the high

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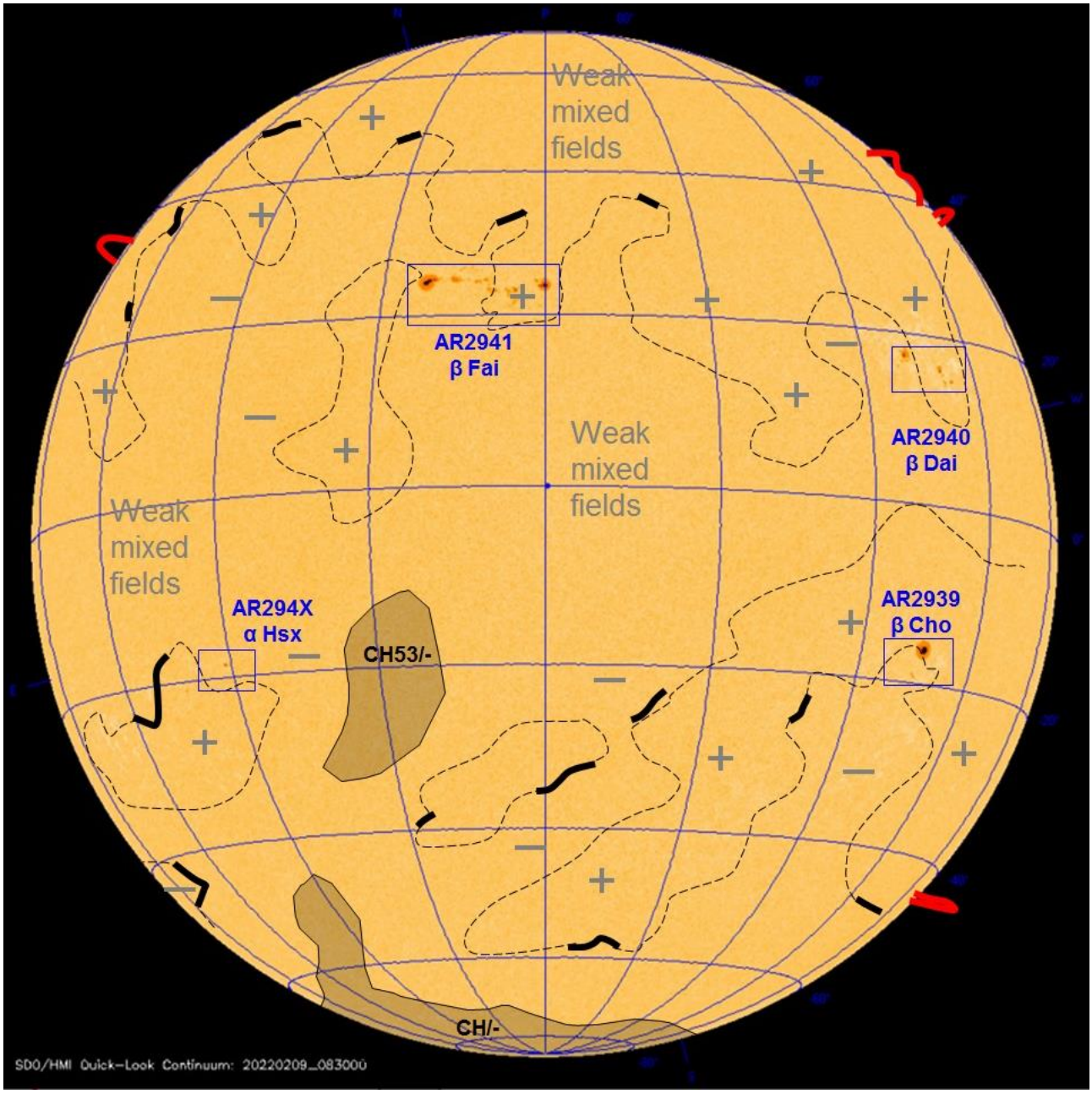
(1e3pfu) level by day 2 (10 February) post arrival of the CME recovery is then uncertain. Active (1e8 integrated pfu) electron fluence levels on day 1 (09 February) with a decline likely by day 2. Any recovery is subject to the behaviour of the electron flux following the CME.

Figure 1. Solar Analysis Valid 0800UTC, 09 February 2022.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

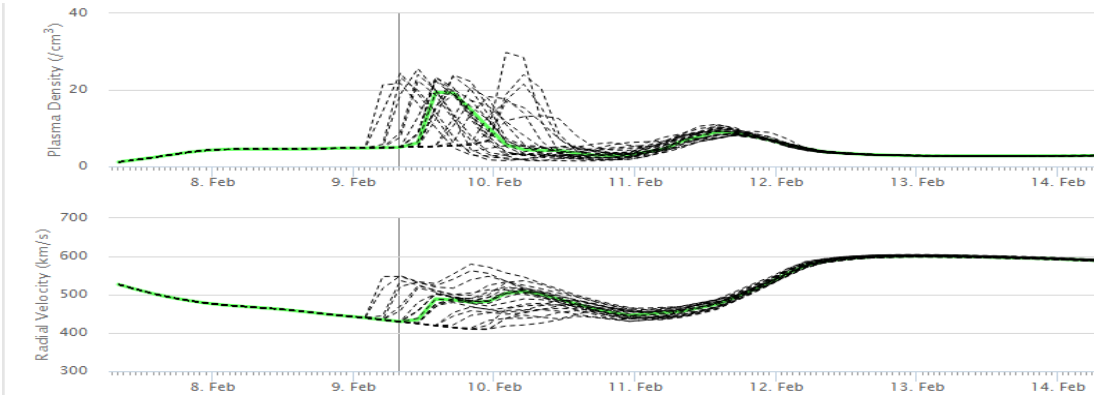
A CME which left the Sun 06 February is forecast to arrive on day 1 (09 February). The filament eruption which gave rise to the CME erupted from centre disc in the region of AR2939, but the resultant halo had a notable southeastward trajectory and this gives some uncertainty in timing and impacts at Earth. Enlil is suggesting that the main portion of the feature may pass close to the east of the Earth, but a significant portion of the CME is still expected. Interestingly the MOSWOC Enlil ensemble gives fairly wide spread for arrival times. The next coronal hole high speed stream, from coronal hole 53, looks set to arrive on day 4 (12 February), with peak of 600-700km/s, based on persistence from this recurrent feature.
Geomagnetic activity is expected to start Quiet before becoming Unsettled to Active with a Chance (20-50%) of G1/Minor Storms on arrival of the CME. Residual effects of the CME are then possible through days 2 and 3, which are dependent on the post-shock magnetic sheath. The onset of the equivalent high speed stream from coronal hole 53 generated G1/Minor Storms on the last rotation, with a similar effect possible, especially in a primed post-CME environment.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	50	50	20	20
Strong	G3	No	5	5	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
07/0003	Partial	Filament near AR2939	Centre disc	400	090/1000UTC	Chance o G1

Figure 2: Met Office Enlil ensemble output showing spread of arrival times.



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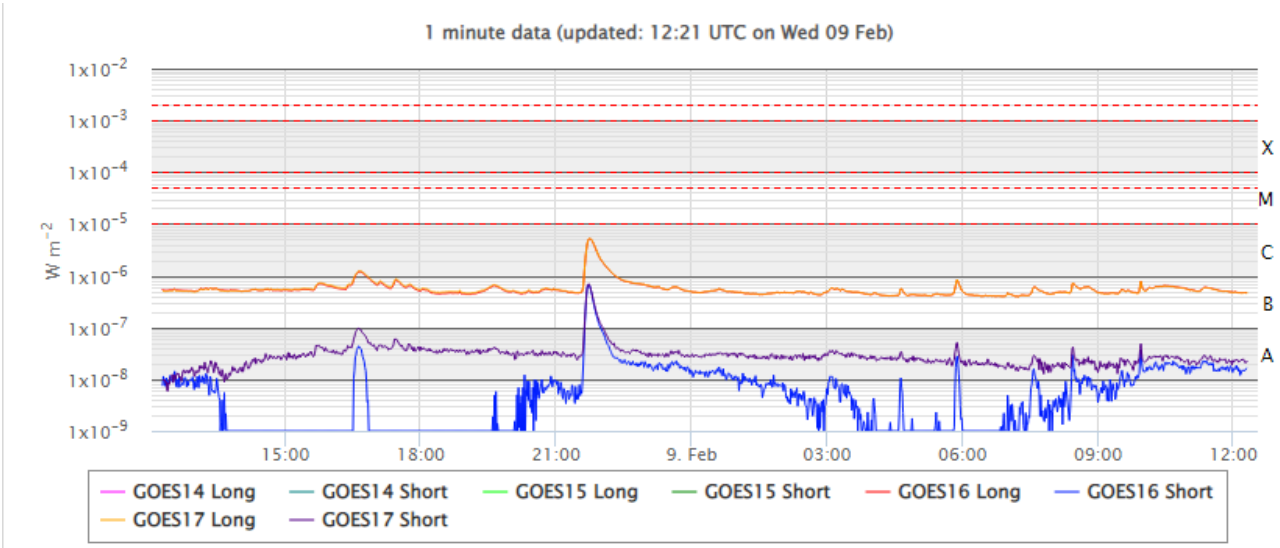
Radio Blackouts - X-Ray Flares:
There are four sunspot regions on the visible disc, with three of the larger regions, 2939, 2940 and 2941 all passing through periods of development, with subsequent subdued periods. 2941 is the largest region and classified as Fai/Beta, with several intermediate spots in evidence. 2940 (Dai/Beta) seems to be relatively stable with the looping appearing uniform. 2939 (Cho/Beta), from where the 06 February CME emanated, produced a C5.1 flare overnight, 2943 is relatively new and currently benign with a uni-polar structure (Hsx/Alpha).
Solar activity is expected to be mainly low, with further, mostly low level, C-class flaring continuing. Based on the position and history of the three largest regions, there is a chance of an M-class flare through the next 4 days.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	30	30	30	30
Very Active	R3 to R5 X Class	No	2	2	2	2

Figure 3:X-Ray flux plot with several C-Class flares observed at GEO.



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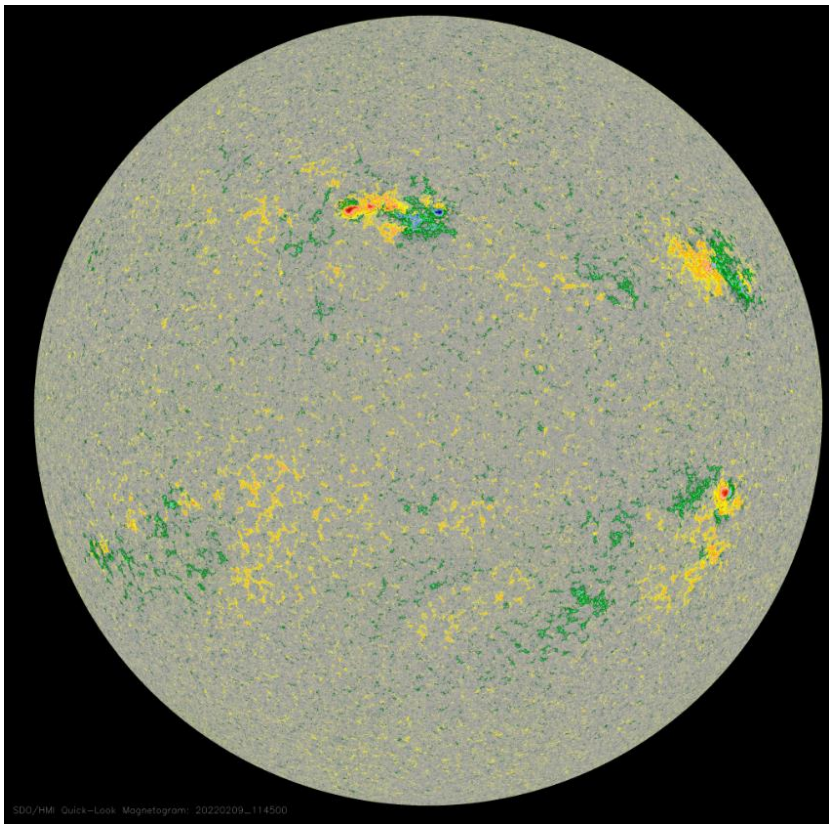
Solar Radiation Storms - (High Energy Protons):

The high energy proton flux, as measured by GOES-16 is at background levels. Solar radiation storms are not expected in the period. However, there is a very slight chance for proton fluxes to rise given any significant flaring from AR2939 and AR2940, as they continue to transit across the western hemisphere.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4:SDO HMI magnetogram satellite imagery, showing most prominent active regions on visible disc.



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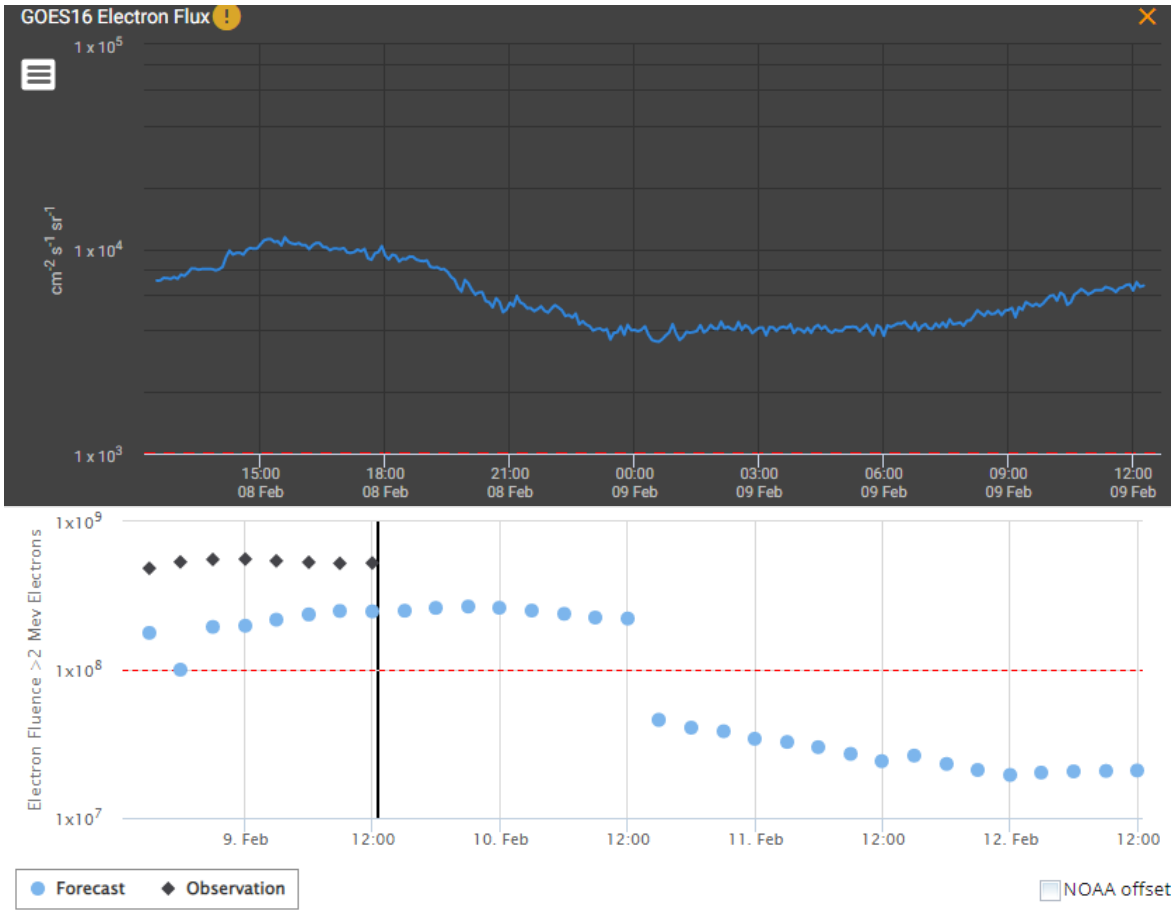
High Energy Electrons Event (≥ 2MeV):
High energy electron flux (greater than 2MeV) starting at high (1e3pfu) levels is likely to fall sharply on commencement of enhanced geomagnetic activity from the forecast CME. The CME could also distort the radiation belts away from GEO. Following the CME arrival confidence in the behaviour of the electron flux decreases, as this depends on the extent of the post CME shock and how quickly the radiation belts may return to an unperturbed state.
24-hour fluence values are expected to remain above the Active (1e8 integrated pfu) threshold through day 1, but then decline as the electron flux decreases from day 2 (10 February). The probabilities represent the uncertainty in the level of decline and then the speed of any recovery.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	Yes	100	80	60	40
Very Active	≥ 2 MeV ≥ $1x10^9$	No	5	5	1	1

Figure 5:High energy electron-flux and Met Office REFM output.



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